

PATENT SPECIFICATION

709,365



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COMPLETE SPECIFICATION

Improvements in or Relating to Drill Assemblies

We, STANDARD OIL DEVELOPMENT COMPANY, a Corporation duly organised and existing under the Laws of the State of Delaware, United States of America, of Elizabeth, New Jersey, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns a novel form of drill assembly. The particular feature of the drill assembly is the manner in which four cutting elements of the bit structure are arranged to permit insertion through and recovery from a drill stem without removing the drill stem from the bore hole in which the drill is employed. The drill is particularly characterized by the combination of a spring mechanism with suitable latching dogs of the apparatus serving to provide positive expansion and retraction of the cone cutters as desired.

In conventional rotary drilling, a suitable drill bit is fixed to coupled sections of pipe called a drill string. As the drill is operated, additional sections of pipe are added to the drill string. Upon failure of the drill bit or when, for any reason, it becomes necessary to replace or service the drill bit, it is necessary to remove the entire drill string from the bore hole in order to recover the drill bit. When the drill bit has been replaced as desired, it is then necessary to reconnect the string of tubing. The time required to conduct these operations in conventional drilling operations accounts for a substantial portion of the drilling costs. It is this factor which makes the provision of a suitable form of retractable drill bit particularly desirable. By provision of a suitable retractable bit it becomes practical to employ casing as the drill string, maintaining the casing within the bore during the withdrawal of the bit and using this casing for production after drilling is completed.

A suitable form of retractable drill bit of a nature to permit insertion and removal through the drill string itself must fulfil certain definite qualifications. First, it must remain in a folded or retracted position while it is being lowered through the drill pipe so that the drill will not jam or lock in the drill pipe inadvertently during lowering. Second, it must positively stop at the bottom of the drill string and expand to a cutting size greater than the diameter of the drill string, preferably while off the bottom of the hole. Third, the drill bit must enable transfer of weight and rotary torsional motion from the drill string to the drill bit in order to secure effective cutting action. Fourth, the drill bit must include means permitting positive retraction of the extended cutting elements to permit the drill bit to be pulled through the drill string without difficulty. Finally, it is necessary that a suitable retractable drill bit have fluid passages arranged therein permitting passage and direction of drilling fluid to the bottom of the hole adjacent the cutters for lubrication of the drill bit and removal of drill cuttings.

The present invention suitably fulfils each of these qualifications and provides a drill assembly comprising a tubular drill collar having a circumferential groove on the inner surface thereof, a retractable drill-bit having a sleeve element fitting in sliding relationship within the said drill collar, bifurcated downwardly-dependent supports fixed to the said sleeve member, a wedge element joining the lower end of the said supports, a first pair of cutting elements pivotally fixed to the lower end of the said supports, a tubular support member extending through said sleeve member in sliding relationship therewith, and a second pair of cutting elements pivotally fixed to the lower end of the said tubular support member between the said bifurcated supports, wherein a spring element acting against the said tubular support member and the said sleeve member

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normally maintains the said second pair of cutting elements above the said wedge element, and latches are fixed to the said tubular support member and are adapted to extend into the said circumferential groove to normally prevent upward movement of the said tubular support member relative to the said drill collar.

The drill assembly of the present invention may be understood by reference to the accompanying drawings, in which Figs. 1 and 2, of which Fig. 2 is the lower continuing extension of Fig. 1, represent a preferred embodiment of the present invention and show the drill assembly in locked extended cutting position;

Similarly, Figs. 3 and 4, taken together, of which Fig. 4 is the lower extension of Fig. 3, shows the drill assembly in retracted position; Fig. 5 is a cross-section of Fig. 1 along the line V—V; Fig. 6 is a cross-section of Fig. 4 along the line VI—VI; Fig. 7 is a cross-section of the lower portion of the drill bit taken through the line VII—VII of Fig. 2; Fig. 8 is a right side view of Fig. 4, showing the lower portion of the drill bit when the cutting assembly is held in retracted position; Fig. 9 is an elevational, cross-sectional view showing the upper portion of a modified form of the drill assembly according to the present invention; and Fig. 10 shows the lower extension of the drill shown in Fig. 9.

In describing the invention, reference will primarily be made to Figs. 1 and 2 of the drawings. However, like reference numerals are applied to similar parts in the remaining figures of the drawings and reference may be made to other figures of the drawings for a better understanding of the apparatus described.

The drill bit is to be employed in conjunction with a specially designed drill collar 1. This drill collar may be fixed to a conventional drill string or a string of casing by means of a threaded coupling or the like. The internal diameter of the drill collar may be substantially that of the drill string with which the drill is used, while the external diameter may be somewhat greater than that of the drill string to provide increased structural strength. The drill collar is essentially a tubular member having an upper portion in which is formed an annular groove 2 in the collar, to provide a shoulder 3 against which latching dogs may bear. A second annular groove 4 adjacent the lower termination of the drill collar similarly provides a shoulder 5 against which other latching dogs may bear.

The retractable drill itself consists of three principal tubular elements identified by numerals 6, 20, and 9. As will be seen, upper tubular element 20 and lower tubular element 9, serve as sleeves for tubular element 6

maintained in sliding relationship therewith. The central tubular member 6 extends substantially through the entire drill. A helical spring 7 is mounted on a median portion of tubular member 6, bearing at its upper end against a collar 8 provided on member 6. The lower end of helical spring 7 bears against a sleeve 9 which encircles a lower portion of tubular member 6. Tubular member 6 extends downwardly through sleeve 9 to terminate as an enlarged head 10. Head 10 may be attached to tubular member 6 by threads or other suitable means to facilitate assembly. The head member 10 supports downwardly extending lugs to which two cone cutter supporting arms 11 and 12 may be pivotally attached. Cutters, such as the cone type cutters 13 and 14 illustrated, may be suitably attached to the supporting arms 11 and 12 by means of suitable bearings and trunnions.

Sleeve 9 encircling tubular member 6 is provided with two bifurcated downwardly extending supports 15 and 16. At their lower termination these supports are joined by a wedge-shaped member 17 beneath which two drill cutters, such as the cone cutters 18 and 19 illustrated, may be attached. This construction may be appreciated by referring to Figs. 7 and 8 of the drawings.

As described, consequently, sleeve 9 maintained in sliding relationship with tubular member 6, is urged downwardly with respect to member 6 by spring 7. At the lower limit of downward movement, sleeve 9 is forced against member 10. The spring element thus serves to normally maintain the drill cutters of the apparatus in the retracted position illustrated in Fig. 4. The remaining elements associated with sleeve 9 which are essential for operation are the latching dogs 25 which are pivoted in slots of sleeve 9. Preferably three of these latching dogs are employed, as illustrated. These latching dogs are urged outwardly by leaf springs 26, and serve the function of latching in the lower groove 4 of the drill collar to permit "off-bottom" extension of the drill bit as will be described.

Tubular member 6 extends upwardly in telescopic relationship with an enlarged tubular member 20. Tubular member 20 is provided with a conventional "spearhead" 21 at the upper termination thereof. A number of latching dogs 22, preferably three in number as illustrated, are pivotally fixed in slots provided in the tubular member 6 extending in part through matching slots in tubular member 20. These latching dogs are urged outwardly by leaf spring elements 23. When the slots provided in the outer tubular member 20 register with the slots and latching dogs of member 6, the latching dogs extend outwardly as shown in Fig. 1. However, when member 20 is moved up-

wardly with respect to member 6, the latching dogs are forced into retracted position as shown in Fig. 3. Extensions 24 provided on latching dogs 22, extend through the corresponding slots in sleeve member 20, bearing against the lower edge of the slots when the latches are in the retracted position.

The arrangement of tubular member 6 and sleeve member 20 described is employed to control the extension of latching dogs 22. When the weight of the apparatus is borne by spearhead 21, the weight of the drill causes tubular member 6 to slide downwardly with respect to sleeve member 20 to which the spearhead is fixed. This maintains the members in the position shown in Fig. 3 and maintains the latching dogs 22 in retracted position. The extensions 24 of these latching dogs, bearing on the edge of the slots in sleeve 20 serves to support the weight of the remaining elements of the drill. However, if sleeve 20 is permitted to slide downwardly with respect to tubular member 6, the slots provided in sleeve 20 will register with latching dogs 22 so that these latching dogs can be extended outwardly into latching position by the action of leaf springs 23.

With this description of the principal elements of the drill bit, the manner in which the drill bit operates may be understood. In this description of the operation of the drill bit, reference will also be made to remaining features of the apparatus which are illustrated but which have not heretofore been described in detail. Considering that it is desired to lower the drill bit through a drill string, the drill bit will be placed in the condition illustrated in Figs. 3 and 4. This retracted position of the drill bit is automatically attained by supporting the apparatus by spearhead 21. For this purpose, a suitable wire line tool, having a releasable spearhead latching arrangement, will be attached to spearhead 21. The drill bit may then be lowered into the drill string. As the weight of the drill bit will be carried by the upper sleeve member 20, member 20 will maintain the latching dogs 22 in the retracted position shown in Fig. 3 as formerly described. The lower latching dogs 25 will bear outwardly against the drill string as the apparatus is lowered, but will not impede lowering of the apparatus until these latching dogs contact the shoulder 5 provided in the lower annular groove 4 cut in the drill collar. During the lowering operation, the cone cutters 11 and 12 will be in the retracted position by virtue of spring 7 maintaining the cutters 13 and 14 in a position above the wedge assembly 17.

When the drill bit has been lowered to the point shown in Fig. 4, latching dogs 25 will encounter the shoulder 5 provided at the lower end of the drill collar. Further downward movement of sleeve 9 and the elements fixed to and supported by this sleeve will

then be stopped. On continuing to lower the supporting cable of the apparatus, upper tubular member 20 will slide downwardly with respect to the inner tubular member 6 and the weight of tubular member 20, tubular member 6, and their attached parts will be sufficient to compress spring 7 thus permitting tubular member 6 to slide through member 9. This sliding movement will bring the cone cutters 13 and 14 against the wedge 17 which will force the cutters and the arms 11 and 12 to which they are attached into the extended position illustrated in Fig. 2. Thus, expansion of the bit off the bottom of the hole is achieved.

Also, as tubular member 20 slides downwardly with respect to tubular member 6, with the latching dogs 22 so that these dogs extend outwardly into the upper groove 2 of the drill collar 1 as shown in Fig. 1. The insertion tool may then be released from spearhead 21, and the cable may be removed from the drill string.

The drill string is then lowered until the four cone cutters contact the bottom of the hole and drilling may proceed with weight on the bit applied through latching and driving dogs 22 from shoulder 3 in drill collar 1 to tubular member 6 and thence to the cone cutters.

It will be observed that a passageway for drilling mud is provided through the entire apparatus. This passage extends from ports cut in the upper termination of sleeve 20 adjacent the spearhead 21, through the interior of tubular member 6, to finally terminate in the opening 31 above the wedge-shaped member 17. It is a particular feature of the arrangement illustrated that a tubular extension 34 may be fixed to opening 31 so as to extend downwardly into a cup-shaped recess 35 formed in the wedge-shaped member 17. A packing seal 36 may be fixed in this cup-shaped recess so that the tubular extension 34 may seal therein. Two or more channels 37 may be provided in the wedge-shaped member 17 to provide fluid openings just above and between the cone cutters.

In order to completely seal the fluid channel through the apparatus, it is desirable to position a rubber packing element 38 on tubular member 6 above collar 8. The tapered lower edge of sleeve 20 is adapted to slide between member 6 and packer 38 to force the packer into sealing position against the drill collar as shown in Fig. 1. It will be noted that the provision of the upper sealing packer 38 and the lower packer 36 serves to provide a sealed fluid passage completely through the apparatus to a point adjacent the cutting cones without permitting by-passing of the drilling fluid.

The drill cutter supports 11 and 12 dependent from member 10 are each particularly

shaped to provide a downwardly facing shoulder which is adapted to mate with an upwardly facing shoulder provided on the wedge-shaped member 17 when the extendible cone cutter supports 11 and 12 are forced into the extended position by said member 17. Consequently when the drill is forced to the position shown in Fig. 2 these shoulders will contact each other, holding the extended cutters 13 and 14 in a locked drilling position.

In order to transmit drilling torque from the drill string, through the drill collar to the drill bit, one or more lugs 58 are positioned in groove 2 of the drill collar as shown in Fig. 5. These lugs bear against the latching dogs 22, serving to transmit drilling torque through the drill bit to the core cutters.

In removing the drill bit from the drill collar and through the drill stem when required, other particular features of the drill bit become apparent. To retrieve the drill, the drill string is first raised to lift the drill a few feet off the bottom of the bore hole. This permits the drill to slide downwardly within the drill collar until latching dogs 25 rest on shoulder 5 of annular groove 4 within the lower termination of the drill collar. When a retrieving tool is dropped over spearhead 21 and lifting force is applied, upper sleeve member 20 is pulled upwardly with respect to inner tubular member 6 so as to force the contraction of the upper latching dogs 22 to the position shown in Fig. 3. After latching dogs 22 are retracted to the position shown in Fig. 3, continued lifting force applied to spearhead 21 will relieve the weight compressing spring 7, and tubular member 6 will slide through sleeve 9, thus permitting the head 10 with arms 11 and 12 attached to move away from wedge 17 and assume the position illustrated in Fig. 4. The entire drill bit may then be withdrawn from the drill collar and drill string. Should the bit be obstructed so that member 6 will not slide through sleeve 9 and permit arms 11 and 12 to retract, continued upward force on spearhead 21 will pull the drill up until the back faces of latching dogs 25 contact the shoulder 59 in drill collar 1. Sleeve 9 will then be prevented from moving upward until tubular member 6 is pulled through sleeve 9 and slots 60 register with inner extensions 61 of latching dogs 25. At that time the bit will be fully retracted and the drill may be removed from the hole.

As emphasized, the type of retractable bit described is particularly intended to permit full extension of the cutters to cutting position off the bottom of the bore hole. In the event it is considered suitable to secure extension of the cutters by forcing the bit against the bottom of the bore hole, to some extent the drill construction can be simplified, and a drill assembly according to the

present invention is illustrated in Figs. 9 and 10.

Referring first to Fig. 9, it will be observed that the general arrangement of the drill is similar to that described. An inner tubular member 6 and an upper and outer sleeve member 20 are employed in the same general manner as has been described. However, the groove 2 positioned in an upper portion of the drill collar 1 is particularly shaped as illustrated to provide a ledge portion of the groove designated by numeral 71. The latching dog 22 is thus adapted to catch on ledge 71 of groove 2 so as to hold the entire drill apparatus from dropping downwardly through the drill collar. As a result it is possible to dispense with the lower annular groove 4 of the drill collar of the nature shown in Fig. 2 and Fig. 3. Similarly the latching dogs 25 of these figures are no longer necessitated. As a result the lower portion of the drill to be employed with the construction of Fig. 9 is of the nature shown in Fig. 10.

The operation of the drill illustrated in Fig. 9 and 10 is similar to that formerly described. However, to secure extension of the cutters, it is necessary to lower the drill string so that contact against the bottom of the bore hole will provide the necessary force to move sleeve 9 upwardly with respect to tubular member 6 to force extension of the cutters 13 and 14. It will be observed that latching dogs 22 prevent upward movement of the apparatus in the drill collar to permit extension in this manner when the drill string is lowered.

Employing the drill assembly of Figs. 9 and 10, it is preferred to drop the drill downwardly through the drill string. For this purpose a shear pin 62 is preferably passed through sleeve member 20 and is fastened in annular member 6. This shear pin serves to hold the slots of sleeve member 20 in register with latches 22. Consequently, as the drill bit is dropped through the drill string, latches 22 will remain in the extended position so that when the drill bit reaches annular groove 2, latches 22 will catch therein to prevent the drill from dropping completely through the drill collar.

A particularly desirable feature of the drill assembly of Figs. 9 and 10 concerns provision for slowing the drill as it drops through the drill string. For this purpose an enlarged central chamber 63 is preferably positioned in the upper termination of annular member 6. A check valve arrangement 64 is positioned at the upper end of chamber 63 in the manner illustrated. Thus a web member 65 is fixed in the upper opening of annular member 6. Web member 65 includes a restricted collar element adapted to support the valve stem of valve 64. Valve 64 is shaped to fit against the upper inner surface

of chamber 63 so as to seal the passageway therethrough leaving the restricted channel 66 through the valve stem itself. However, when valve 64 drops to the downward position illustrated in Fig. 9, a substantially greater fluid passage is available through the annular space around collar 65 of the web member.

Employed in conjunction with this check valve arrangement is a flexible packer element 67 which may be positioned in the external wall of annular member 6 just above the spring 7. Packer member 67 is employed to seal one or more ports cut through annular member 6. When a positive pressure is provided within the tubular passage of annular member 6, the packer is thus extended so as to contact and press against the drill collar 1.

Consequently, when a drill bit of this construction is dropped into a drill string, fluid will be forced upwardly through the lower tubular member 34 and through the central passage provided in tubular member 6. Passage of the fluid upwardly through the drill in this manner forces valve 64 to fit against the upper termination of the annular member 6. As a result the fluid is forced to pass through the restricted opening 66 in the valve stem. This serves to build up a positive pressure within the annular member 6 which in turn serves to expand the packer element 67 against the drill collar. As a result dropping of the drill through the drill string is slowed to a desirable extent.

It may be observed that this action is self-regulated. If packer 67, for example, were extended so fully as to stop dropping of the drill, the positive pressure within the annular member 6 would be eliminated. This would cause packer 67 to contract permitting the drill to continue to drop.

In order to remove the drill bit of Figs. 9 and 10 from the drill string after completion of drilling operations, a retrieving tool is dropped through the drill string to engage the spearhead 21. When this occurs, shear pin 62 will be broken permitting sleeve 20 to slide upwardly so as to retract the latching dogs 22. In other respects the retraction operation will be of the nature described.

What we claim is:—

1. A drill assembly comprising a tubular drill collar having a circumferential groove on the inner surface thereof a retractable drill-bit having a sleeve element fitting in sliding relationship within the said drill collar, bifurcated downwardly dependent supports fixed to the said sleeve member, a wedge element joining the lower end of said supports, a first pair of cutting elements pivotally fixed to said lower end of the said supports, a tubular support member extending through said sleeve member in sliding relationship therewith, and a second pair of

cutting elements pivotally fixed to the lower end of the said tubular support member between said bifurcated supports, wherein a spring element acting against said tubular support member and said sleeve member normally maintains the said second pair of cutting elements above the said wedge element, and latches are fixed to said tubular support member are adapted to extend into said circumferential groove to normally prevent upward movement of the said tubular support member relative to the said drill collar.

2. The drill assembly as claimed by Claim 1 wherein further latches are fixed to the said sleeve element and are adapted to limit downward movement of the said sleeve element with respect to the said drill collar.

3. The drill assembly as claimed by Claim 1 in which the said tubular support member contains an elastic packing element adapted to form a fluid seal between the said tubular support member and the drill collar, whereby positive pressure within the said tubular support member expands the said elastic packing element against the said drill collar.

4. The drill assembly as claimed by Claim 1 or Claim 3 wherein a check valve is positioned in the upper end of the said tubular support member whereby upward fluid flow through the said tubular support is impeded.

5. The drill assembly as claimed in any of Claims 1, 3 or 4 wherein a shear pin passes through the said sleeve element and is fastened in the said tubular support member whereby the position of the said tubular support member is fixed relative to the said sleeve element during lowering of the said sleeve element within the aforesaid tubular drill collar, and whereby the aforesaid latches are in the extended position during the said lowering and are subsequently engaged in the aforesaid circumferential groove, and the said shear pin is adapted to break when the said sleeve element is subsequently raised, and permitting the said sleeve element to move upwardly relative to the said tubular support, whereby the said latches are retracted.

6. A drill assembly comprising a tubular drill collar having an upper and a lower circumferential groove on the inner surface thereof, a retractable drill-bit fitting in sliding relationship within the said drill collar, the said retractable drill-bit fitting comprising an elongated central tubular member, a first sleeve member fitting over the upper portion of said tubular member, a second sleeve member fitting over a median portion of said tubular member, a pair of cutting elements pivotally fixed to the lower end of said tubular member, a pair of downwardly dependent supports fixed to said second sleeve member, a wedge member fixed to the lower termination of said dependent sup-

ports, a further pair of cutting elements pivotally fixed to the lower end of the said supports, latches pivotally fixed to said second sleeve member, and adapted to extend into said lower circumferential groove, and further latches pivotally fixed to said central tubular member and adapted to extend into said upper circumferential groove, said first sleeve member including a slotted portion normally registering with said further latches.

7. The drill assembly as claimed by Claim 6 wherein a spring element normally urges

said second sleeve member downwardly with respect to said central tubular member. 15

8. The drill assembly as claimed in any of Claims 1 to 7 wherein the latches therein claimed consist of pivoted spring-loaded latching dogs normally urged outwardly.

9. Improved drill assemblies as hereinbefore described, and illustrated in the accompanying drawings. 20

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FIG. 1.

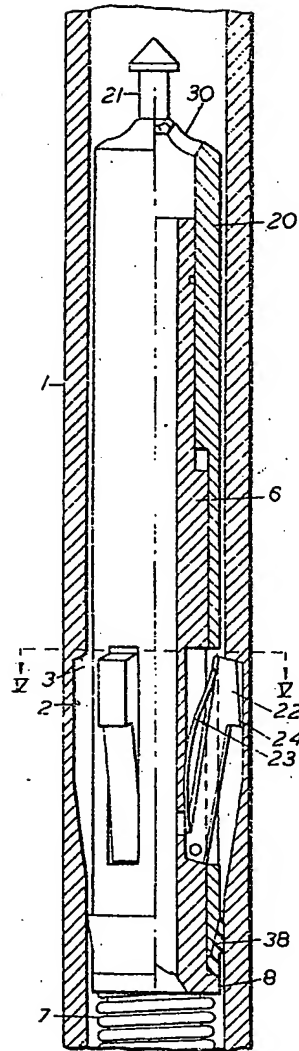
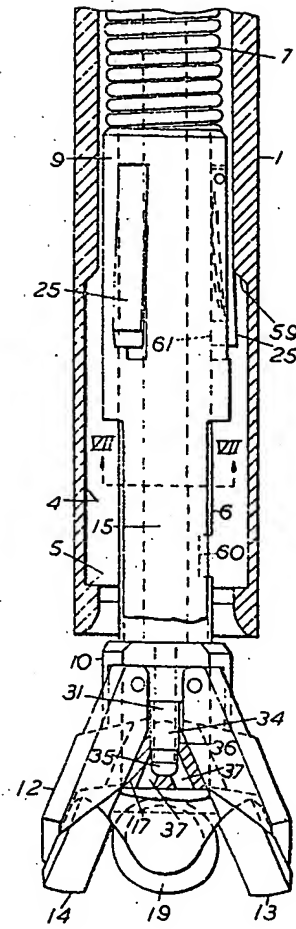


FIG. 2.



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SHEETS 1 & 2

FIG.3.

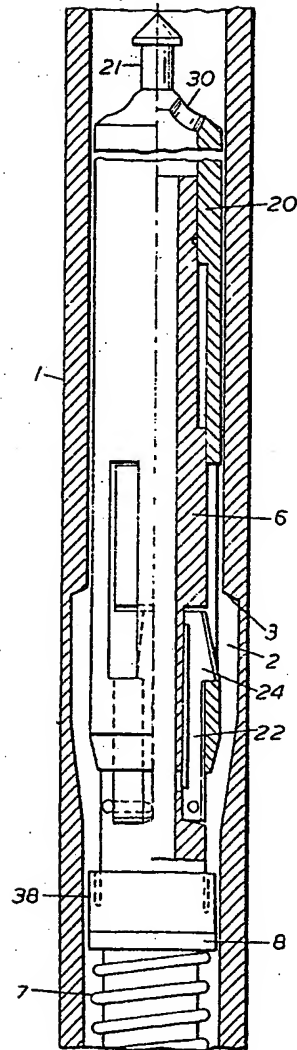


FIG.4.

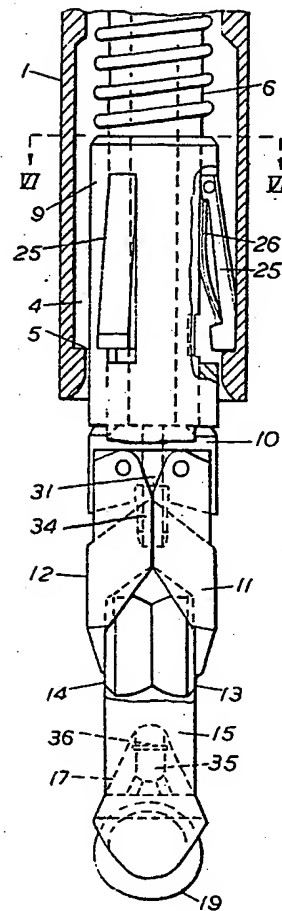


FIG. 1.

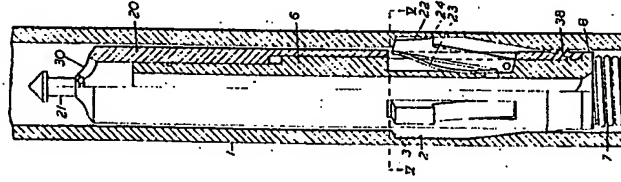


FIG. 2

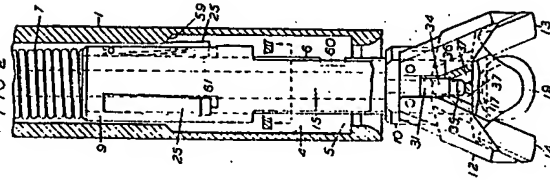


FIG. 3.

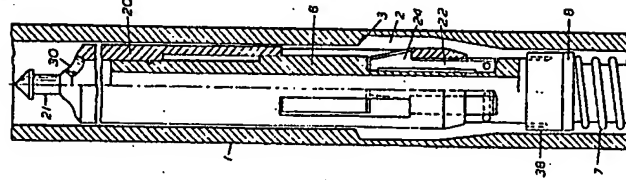


FIG. 4.

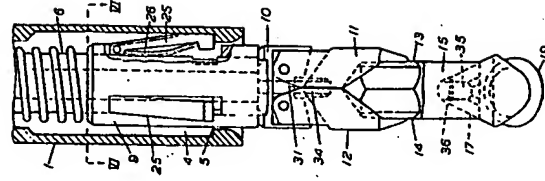


FIG. 5.

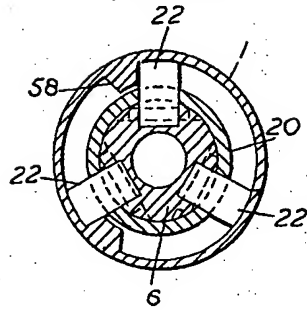


FIG. 6.

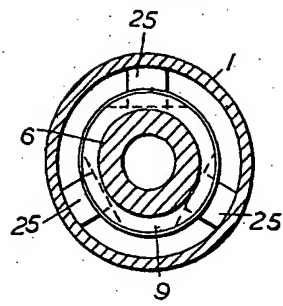


FIG. 7.

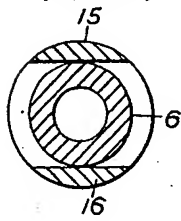
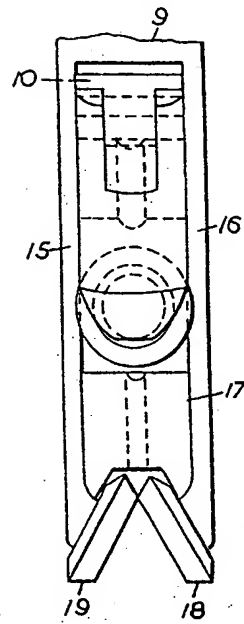


FIG. 8.



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SHEETS 3 & 4

FIG. 9.

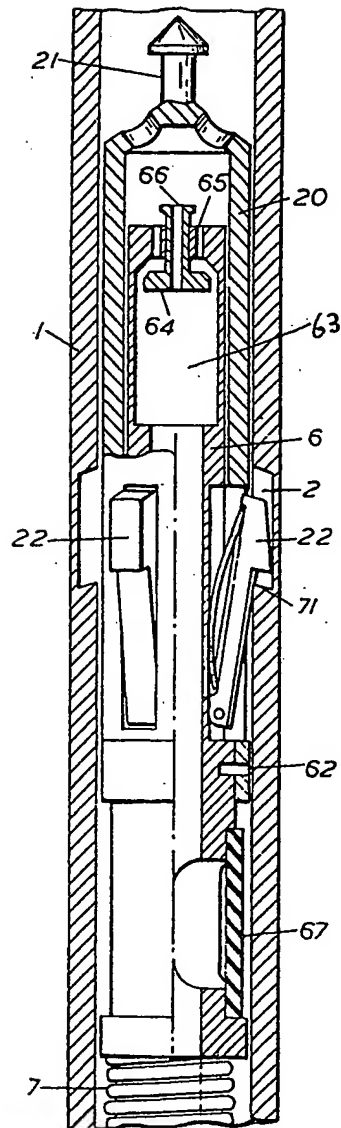
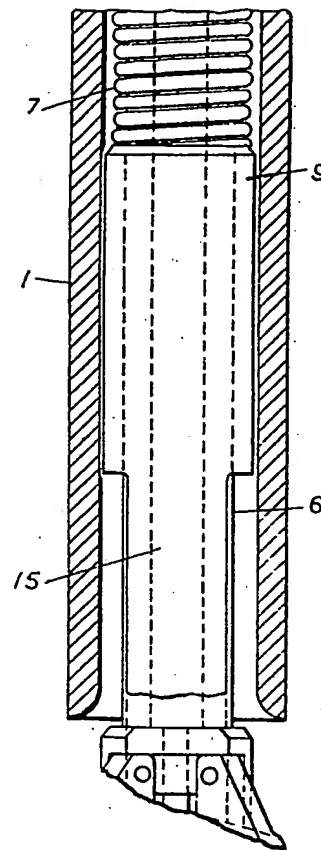
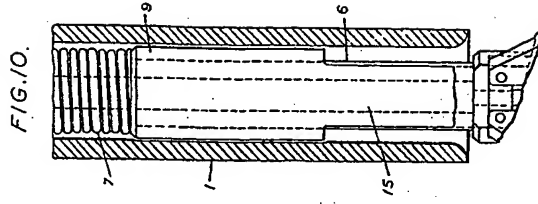
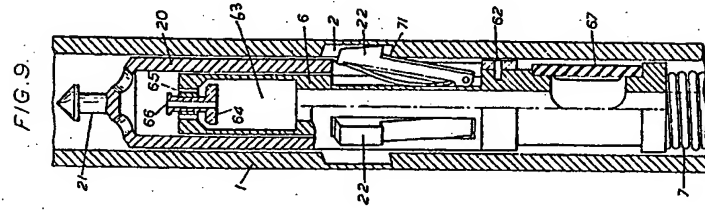
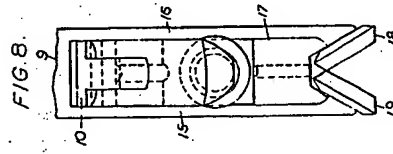
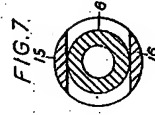
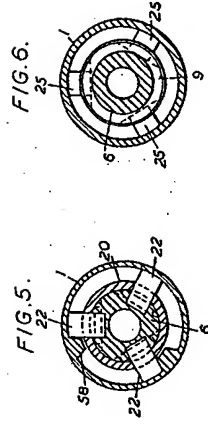
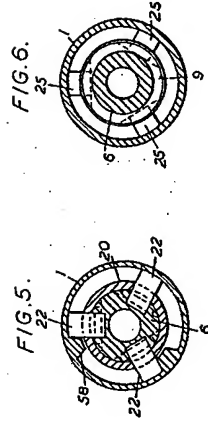


FIG. 10.





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